TITLE
VOLTAGE-CONTROLLED
OSCILLATOR VCO3-A
(ATS 1700502)
(P/N ALL VCO FOR XN)

LOCKHEED AIRCRAFT CORPORATION
MISSILE SYSTEMS DIVISION

TEST PROCEDURE
MANUFACTURING
M700502

SHEET 1 OF SHEETS

PREPARED 42-64	TEST-DEPT 42-43	DESIGN-DEPT 58-21	RELEASE 42-64
R S SORENSON 4-17-9 R. Sorenson	T. J. Ferguson	R. Helseth R. Helseth	W. C. Davis W. C. Davis

REVISIONS

SYM	DATE	DESCRIPTION		FOR TEST	FOR DESIGN
New Test	10-15-8	Revision -	Effectivity AX-9 and up	A. Martin	L. Maxwell
A	1-14-9	Complete	AX-10 and up	V. Blue	L. Maxwell
B	3-2-9	Page 6, para. 7.6	AX current serial	R. Sorenson	R. Helseth
B N/C	4-6-9	Typo errors	AX current serial	R. Sorenson	R. Helseth
B N/C	4-17-9	Typo errors 5.7	AX, AlX-1 and up	R SORENSON 4-16-9	R. Helseth

NOTE: Sections 1 through 6 are to be considered preliminary adjustments and do not require inspection surveillance.

1. TEST EQUIPMENT:

1.1 All equipment included in oscillator set-up station.

1.2 Test Harness Q1081T.

2. POWER SUPPLIES:

2.1 Set plus 28 volt supply to +28.0 ± .1 volt DC.

2.2 Set negative 28 volt supply to -28.0 ± .1 volt DC.

2.3 Plug in oscillator.

2.4 + 28 volt current drawn by oscillator shall not exceed 12.0 milliamperes.

2.5 -28 volt current drawn by oscillator shall not exceed 4.0 milliamperes.

3. FILTER CHECK:

3.1 The filter shall meet the following specifications: (Unsolder R29).

3.1.1 Maximum pass-band amplitude variation: 1.5db max.

3.1.2 Upper and low adjacent band edge attenuation: 10 db min. Channel 6 and above; 8 db in channel 5 and below.

3.1.3 Second and third harmonic attenuation: 25 db min.

5. Initial Adjustments and Checks: (Continued)

5.2 The following adjustments should be made using a setup as shown in Fig. III, Page 14, with unit plugged into setup station without cable.

5.3 With zero volt stimulus input, adjust R4 (20K) so that the voltage at test point is + 7.0 VDC. The frequency of the oscillator should now be in the band as specified in the band-frequency Table IV.

5.4 Place the probe of a high frequency oscilloscope at the collector of Q1, and verify that C4 and C20 are being discharged to the B-level set by CR4 (approximately 24V) as in sketch, bottom of page 8.

If the capacitors are not being completely discharged, decrease R10 until they are completely discharged, but do not use less than 100 ohms for R10. If C4 and C20 are still not being completely discharged, assign unit to rework group for replacement of Q1.

5.5 Adjust R7 (1K) for correct center frequency. If the correct center frequency cannot be obtained by varying R7, decrease the sum of C4 and C20 to increase the frequency. Increase the sum to decrease frequency. R7 should be near the center of its range.

5.6 With -0.75 VDC stimulus applied, adjust R13 (25K) for the desired high bandedge frequency shown in Table IV. Apply +0.75 VDC stimulus and check the low bandedge frequency against the value in Table IV.

5.7 Vary B+ ± 0.5V. Record the center frequency and bandedge frequencies. B+ current should also be recorded for each B+ setting. The center frequency and the bandedge frequencies should not vary more than ±1.0% of bandwidth. Vary B- ±0.5V. Record the center frequency and bandedge frequencies. The center frequency and the bandedge frequencies should not vary more than ± 1% of bandwidth. B- current should also be recorded for each B- setting. If in either case the change of frequency is excessive assign to rework. At rework, check the two voltage regulator circuits made by CR3 and R3 and CR4 and R6.

5.8 Adjust R28 (10K) so that the VTVM reads listed output with zero volt stimulus.* Make sure that R28 is at least one turn from its maximum setting. If the desired output cannot be obtained, assign to rework. At rework, verify that there is a square wave output on the collector of Q5. If there is not a square wave output, change the bias on Q5 by varying R25. Also it may be necessary to increase the coupling by decreasing R24 (to a minimum of 2K). It is only necessary to check the wave form at collector of Q5 when the output voltage is low, or when the output distortion (see 5.4) is very high.

CAUTION: Plug oscillator into panel for output measurements.

* NOTE: 0.250 volts channel 13 through 15.
0.36 volts channel 16 and above (including A & E)
0.100 volts channel 3 through 12.

5. Initial Adjustments and Checks: (Cont'd)

5.9 Measure the total harmonic distortion at the center frequency. The total harmonic distortion should be less than 1.5%. If distortion is high add C21, shunting R25; the value shall be between 5 to 1000 mmfd. Use type CY10 - CY15 Corning Glass or DM 15 capacitors.

5.10 Ground the tell-tale terminal R and measure RMS output level and percentage of distortion at center frequency. Output level should fall at least 25%, but not more than 35%. Percentage of distortion should not exceed 1.5% at center frequency. Tell-tale resistors should be lab-set as required.

6. TEMPERATURE COMPENSATION: Use cable from station panel to oven.

6.1 It is recommended that all oscillators be temperature cycled three times without B+ before starting this test. Use a setup as shown in Fig. III (Page 14). A half hour warm-up of the VCO-3A is recommended before the heat run. At room temperature apply + 0.75V, 0 V and -0.75V stimulus. Measure and record the lower band-edge, the center and high band edge frequencies. Also record the output voltage at center frequency.

6.2 Place the oscillator into an oven which has been preheated to 65°C (149°F). When the oscillator has stabilized measure and record the same quantities as in 6.1 (20 minutes min.)

6.3 Remove the oscillator from the oven and after it has stabilized at room temperature, measure and record the same quantities as in 6.1. The frequencies should return to within 1% of bandwidth as their initial value. If not, repeat 6.2. If oscillator is still out of tolerance after second heat run, assign unit to rework.

6.4 If the total change of the lower band edge frequency, the center frequency or the upper band edge frequency is more than ± 2% of bandwidth the oscillator will have to be compensated, output as measured at end of cable shall not change by more than 10%.

Since normally all compensation is done by various resistors, examples of the different types to be used are given below.

6. Temperature Compensation: (Cont'd)

6.4.1	Temperature Characteristics:	Resistor
6.4.1.1	Zero coefficient	Dalohm WWA-13
6.4.1.2	Positive coefficient	Ultronics Type 105R + 0.4% per °C
6.4.1.3	Negative coefficient	Dalohm 1/8W composition film

The following table will be useful in compensating the VCO3A.

6.4.2	Drift Characteristics:	Probable Cure
6.4.2.1	Constant rise of frequency with temperature; total variation of frequency being less than 6% of BW	Replace 50K zero coefficient by a small positive coefficient R8 and a zero coefficient R9, keeping the sum equal to 50K.
6.4.2.2	Frequency at 65° less than the frequency at 25°C, but the frequency variation over the temp. range is less than 6% of bandwidth.	Replace 50K zero coefficient by negative coefficient R8 and zero coefficient R9, keeping the sum equal to 50K.

(See Table 6, page 17 for approximate values.)

The following corrective measures should be made by the rework groups:

6.4.2.3	Increase of frequency with temperature, and the total variation of frequency being more than 6% of BW.	1. Replace CR1. 2. Decrease blocking osc. freq. 3. The voltage on CR3 should not vary more than 0.2V over the temperature range.
6.4.2.4	Center frequency at 65° more than 6% of bandwidth below the frequency of 25°C.	Replace Q1 by another transistor selected to Q1 specifications.
6.4.2.5	Sensitivity changes on low frequency side.	Decrease the blocking oscillator free-running frequency.
6.4.2.6	The output voltage decreases by more than 10%.	Change L1 and L2, retune filter.

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7. LINEARITY: FINAL CHECKS AND ADJUSTMENTS AFTER PART INSTALLATION AND POTTING. CAUTION: Plug oscillator into panel for these measurements. The inspection department must maintain surveillance of all tests in this section.

7.1 Set up oscillator per Figure 3.

7.2 Set plus 28 volt supply to +28.0 ± .1 volt DC.

7.3 Set negative 28 volt supply to -28.0 ± .1 volt DC.

7.4 Plug in oscillator.

7.5 + 28 volt current drawn by oscillator shall not exceed 12.0 milliamperes.

7.6 - 28 volt current drawn by oscillator shall not exceed 4.0 milliamperes, with tell-tale grounded.

7.7 Apply ± 0.75 VDC stimulus in 11 equal steps.

7.8 Record output frequency for each step. Use 10 sec. gate on counter at 3 KC and below. (Channels 3 thru 8).

7.9 Subtract high and low band edge frequency, as measured in 7.7.

7.9.1 Divide this figure by 10.

7.9.2 Subtract each reading from the next highest reading.

7.9.3 The values in 7.9.2 should be the value in para. 7.9.1 ± the 1% tolerance in Table I.

7.10 Check the band edge and center frequencies are still in tolerance as indicated in Table V.

8. OUTPUT: At ambient temperature, record the following:
CAUTION; Plug oscillator into panel for output measurements.

8.1 Adjust R28 so VTVM reads .10 volts rms, channel 3 thru 12; 0.25 volts rms, channel 13 thru 15; 0.36 volts rms, channel 16 and above (including A & E). Tolerance on these voltages are -0 +3%.

8.2 Center frequency, RMS Output Voltage, % distortion, (E_{in} = 0V)

8.3 Lower band-edge frequency, RMS Output Voltage, (E_{in} = +0.75V)

8.4 Upper band-edge frequency, RMS Output Voltage, (E_{in} = -0.75V)

8.5 The output voltage should not vary over the bandwidth more than 2 db. The percentage of distortion in the output at center frequency should not exceed 1.5.

8. OUTPUT: (Cont'd)

8.6 Ground the tell-tale terminal R and measure RMS output level and percentage of distortion at center frequency. Output level should fall at least 25%, but not more than 35%. Percentage of distortion should not exceed 1.5%.

9. TEMPERATURE TEST:

9.1 Plug oscillator into test cable from station panel to oven.

9.2 When oscillator has stabilized record the center, upper and lower band edge frequency. Measure center frequency output voltage.

10. TEMPERATURE TEST 65°C: Use cable from station panel to oven.

10.1 Place the VCO-3A into an oven pre-heated to 65°C (149°F). When the oscillator has stabilized, record the center, upper and lower band-edge frequencies. The frequencies measured should not vary more than ± 3% of bandwidth from that recorded at ambient temperature. See Table 1.

11. FINAL SENSITIVITY ADJUSTMENT, if required and called out by shop order. This section will not be used unless called out on shop order.

11.1 Plug oscillator into test panel.

11.2 Any 1.5 volt peak to peak input range within the limits of ± 2.0 volts is acceptable.

11.3 The output frequency shall be at the center frequency with the input at the center of the desired input range; adjust R4. See Table V.

11.4 The output frequency shall deviate within the lower band limits per Table V, when most positive input of the desired input range is applied.

11.5 The output frequency shall deviate within the upper band limits per Table V when most negative input of the desired input range is applied.

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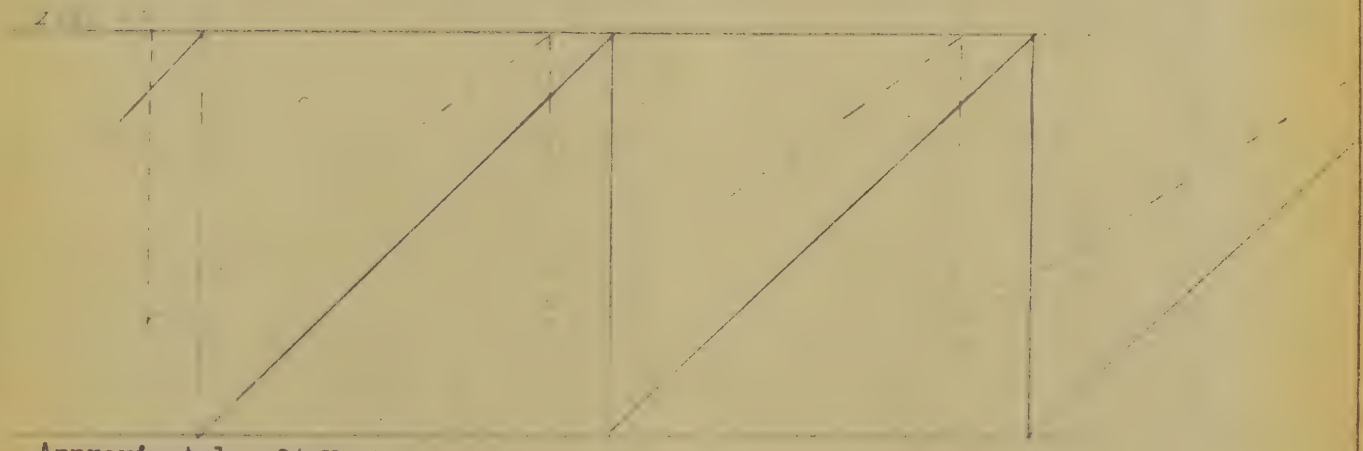
TABLE I

CHANNEL	TOLERANCES PLUS OR MINUS			
	1%	1.5%	2%	3%
1	.6	0.9	1.2	1.8
2	.8	1.2	1.6	2.4
3	1.1	1.6	2.2	3.3
4	1.4	2.1	2.8	4.2
5	1.9	2.9	3.8	5.8
6	2.6	3.9	4.2	7.8
7	3.5	4.3	7.0	10.5
8	4.5	6.8	9.0	13.5
9	6.0	9	12	18
10	8.0	12	16	24
11	11.0	17	22	34
12	16.0	24	32	48
13	22.0	33	44	66
14	33.0	50	66	99
15	45.0	68	90	136
16	60.0	90	120	180
17	79.0	119	158	238
18	105.0	158	210	316
A	66.0	99	132	188
E	210.0	315	420	630



Approximately -24 V DC

*This voltage level set by CR4
Solid line - C4 and C20 completely discharged.

Dashed line - C4 and C20 NOT completely discharged.

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REVISED:

LOCKHEED AIRCRAFT CORPORATION
MISSILES and SPACE DIVISION
SUNNYVALE, CALIF.

TITLE
MANUFACTURING TEST PROCEDURE
VOLTAGE CONTROLLED OSCILLATOR - VCO3A

M700502

SHEET 8 OF 17

FORM MSD 675A-1

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MANUFACTURING TEST PROCEDURE
VOLTAGE CONTROLLED OSCILLATOR

TABLE II

CHAN.	CENTER FREQUENCIES 0-DB	BAND EDGE FREQUENCIES 1.5 DB Max. Variation Over the Band		ADJ. BAND EDGE FREQUENCIES -10 DB or * Less than 0.245 V.RMS		2ND HARMONIC FREQUENCIES -25 DB or Less than .0435 V. RMS	3RD HARMONIC FREQUENCIES -25 DB or Less Than .0435V.RMS
	fo	LOW	HIGH	LOW	HIGH	2. fo	3.fo
3	730	675	785	602	888	1460	2190
4	960	888	1032	785	1202	1920	2880
5	1300	1202	1398	1032	1572	2600	3900
6	1700	1572	1828	1398	2127	3400	5100
7	2300	2127	2473	1828	2775	4600	6900
8	3000	2775	3225	2473	3607	6000	9000
9	3900	3607	4193	3225	4995	7800	11700
10	5400	4995	5805	4193	6799	10800	16200
11	7350	6799	7901	5805	9712	14700	22050
12	10500	9712	11288	7901	13412	21000	31500
13	14500	13412	15588	11288	20350	29000	43500
14	22000	20350	23650	15588	27750	44000	66000
15	30000	27750	32250	23650	37000	60000	90000
16	40000	37000	43000	32250	48550	80000	120000
17	52500	48500	56450	43000	64750	105000	157500
18	70000	64750	75250	56450	90000	140000	210000

*channels 3,5, and 4 -8 db or less than 0.31 volts

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CHANNEL SET COMPONENTS

LAB SET COMPONENTS - SUGGESTED STARTING VALUES

CH No.	C6	C1	C13	C10	R21	C4	C20	MAX.	MIN.
3	.01 ufd (6)	1.5 ufd (6)	0.33 ufd (6)	0.33 ufd (6)	20K	10000 uuf (1)	7500 uuf (1)	650	500
4	.01 ufd (6)	1.5 ufd (6)	0.22 ufd (6)	0.27 ufd (6)	18K	10000 uuf (1)	3600 uuf (1)	850	650
5	.01 ufd (6)	1.5 ufd (6)	0.22 ufd (6)	0.22 ufd (6)	20K	9100 uuf (1)	1000 uuf (4)	1100	900
6	.01 ufd (6)	1.0 ufd (6)	0.1 ufd (6)	0.15 ufd (6)	22K	6800 uuf (1)	470 uuf (5)	1450	1200
7	.01 ufd (6)	1.0 ufd (6)	0.068 ufd (6)	0.10 ufd (6)	18K	4700 uuf (2)	470 uuf (5)	1940	1600
8	.01 ufd (6)	0.68 ufd (6)	0.047 ufd (6)	.082 ufd (6)	22K	3900 uuf (2)	110 uuf (5)	2550	2100
9	.0047 ufd (6)	0.47 ufd (6)	0.047 ufd (6)	.068 ufd (6)	18K	2700 uuf (3)	300 uuf (5)	3350	2700
10	.0047 ufd (6)	0.33 ufd (6)	0.033 ufd (6)	0.047 ufd (6)	18K	1100 uuf (4)	1100 uuf (4)	4600	3750
11	1200 ufd (4)	0.22 ufd (6)	0.027 ufd (6)	.047 ufd (6)	18K	820 uuf (5)	820 uuf (5)	6250	5150
12	1200 ufd (4)	0.22 ufd (6)	0.027 ufd (6)	.022 ufd (6)	22K	820 uuf (5)	240 uuf (5)	8950	7350
13	820 uuf (5)	0.1 ufd (6)	0.014 ufd (6)	.022 ufd (6)	20K	680 uuf (5)		11000	8500
14	820 uuf (5)	0.1 ufd (6)	0.01 ufd (6)	.014 ufd (6)	20K	510 uuf (5)		12300	9500
15	820 uuf (5)	.068 ufd (6)	0.0056 ufd (6)	.012	20K	360		15000	11000
16	560 ufd (5)	.068 ufd (6)	0.0056 ufd (6)	.01 ufd (6)	20K	240 uuf (5)		20000	14000
17	560 uuf (5)	.047 ufd (6)	0.0056 ufd (6)	.01 ufd (6)	18K	200 uuf (5)		26250	18350
18	560 uuf (5)	.047 ufd (6)	0.0056 ufd (6)	.01 ufd (6)	20K	120 uuf (5)		35000	24500
E	560 uuf (4)	.047 ufd (6)	0.0056 ufd (6)	.01 ufd (6)	20K	120 uuf (5)		35000	24500

1. Corning Glass Capacitor CY30 300 VDCW
2. " " " CY29 399 VDCW
3. " " " CY20 500 VDCW
4. Corning Glass Capacitor CY15 300 VDCW
5. El Menco DM15 or Corning Glass CY15 300 VDCW
6. Sprague 150D-35 WVDC

TABLE IV

MANUFACTURING TEST RROCEDURE
VOLTAGE CONTROLLED OSCILLATOR
(FOR USE BEFORE POTTING)

BAND FREQUENCY TABLE

		LOWER BAND EDGE			CENTER FREQUENCY			UPPER BAND EDGE		
Ch. No.	Band Width	Min. fo- 46% BW	Mean fo- 44% BW	Max. fo- 42% BW	Min. fo- 1% BW	Mean (fo)	Max. fo- +1% BW	Min. fo- +42% BW	Mean fo- +44% BW	Max. fo- +46% BW
3	110	679.4	681.7	683.8	728.9	730	731.1	776.2	778.4	780.6
4	144	893.7	896.8	899.5	958.6	960	961.4	1020.5	1023.4	1026.3
5	196	1210	1214	1218	1298	1300	1302	1382	1386	1390
6	256	1582	1588	1593	1697	1700	1703	1808	1813	1818
7	346	2141	2148	2155	2296	2300	2304	2445	2452	2459
8	450	2793	2802	2811	2995	3000	3005	3189	3198	3207
9	586	3630	3642	3654	3894	3900	3906	4146	4158	4170
10	810	5028	5044	5060	5392	5400	5408	5740	5756	5772
11	1102	6843	6867	6887	7339	7350	7361	7813	7833	7857
12	1576	9775	9807	9839	10484	10500	10516	11161	11193	11225
13	2176	13499	13543	13587	14478	14500	14522	15413	15457	15501
14	3300	20482	20548	20614	21967	22000	22033	23386	23452	23518
15	4500	27930	28019	28110	29955	30000	30045	31890	31981	32070
16	6000	37240	37360	37480	39940	40000	40060	42520	42640	42760
17	7900	48866	49024	49182	52421	52500	52579	55818	55976	56134
18	10500	65170	65385	65590	69895	70000	70105	74410	74615	74830

TABLE V

MANUFACTURING TEST PROCEDURE
VOLTAGE CONTROLLED OSCILLATOR
(FOR USE AFTER POTTING)

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BAND FREQUENCY TABLE

		LOWER BAND EDGE			CENTER FREQUENCY			UPPER BAND EDGE		
Chnl No.	Band Width	Min fo- 47% BW	Mean fo- 44% BW	Max. fo- 41% BW	Min. fo- 1% BW	Mean (fo)	Max. fo + 1% BW	Min. fo +41% BW	Mean fo +44% BW	Max. fo +47% BW
3	110	678.3	681.7	684.9	728.9	730	731.1	775.1	778.4	781.6
4	144	892.3	896.8	900.9	958.6	960	961.4	1019.1	1023.4	1027.7
5	196	1208.2	1214	1219.8	1298	1300	1302	1380.2	1386	1391.8
6	256	1579.2	1588	1595.8	1697	1700	1703	1805.2	1813	1820.8
7	346	2138	2148	2158	2296	2300	2304	2442	2452	2462
8	450	2788.5	2802	2815.5	2995	3000	3005	3184.5	3198	3211.5
9	586	2624	3642	3660	3894	3900	3906	4140	4158	4176
10	810	5022	5044	5066	5392	5400	5408	5732	5756	5780
11	1102	6832	6867	6898	7339	7350	7361	7802	7833	7868
12	1576	9760	9807	9855	10484	10500	10516	11145	11193	11241
13	2176	13477	13543	13609	14478	14500	14522	15391	15457	15523
14	3300	20449	20548	20647	21967	22000	22033	23353	23452	23551
15	4500	27885	28019	28155	29955	30000	30045	31845	31981	32115
16	6000	37180	37360	37540	39940	40000	40060	42460	42640	42820
17	7900	48787	49024	49261	52421	52500	52579	55739	55976	56213
18	10500	65065	65385	65695	69895	70000	70105	74305	74615	74935

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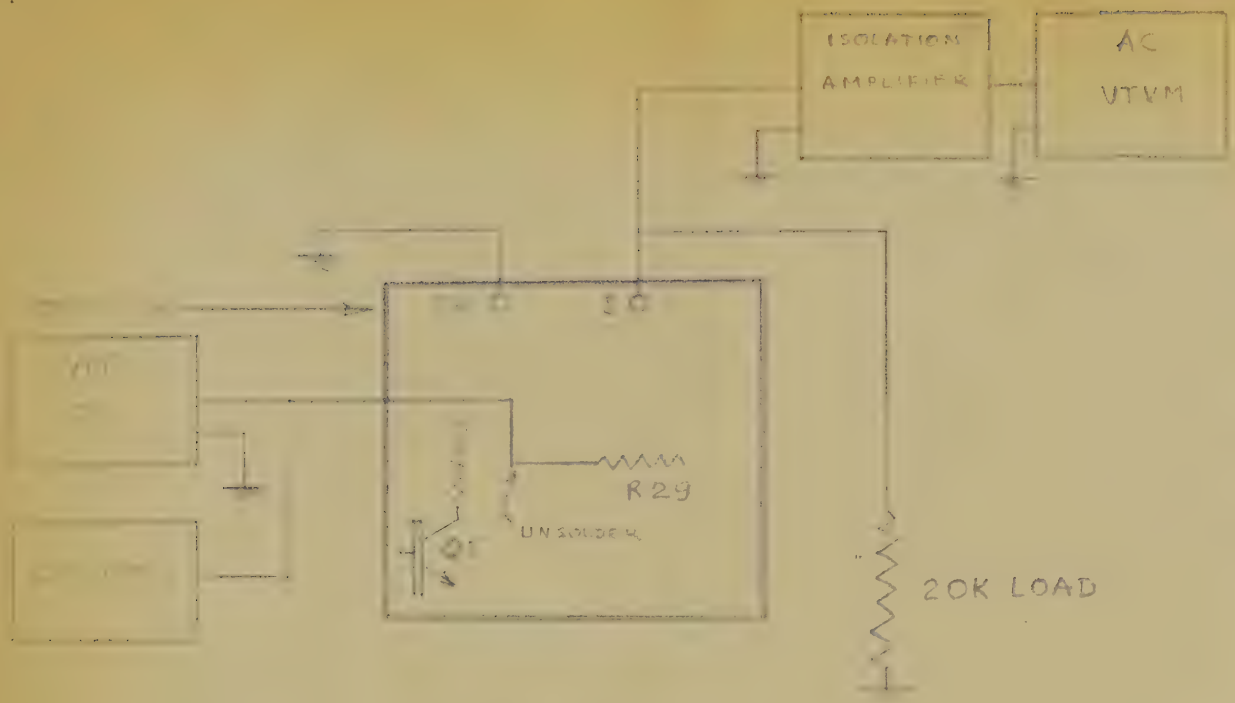
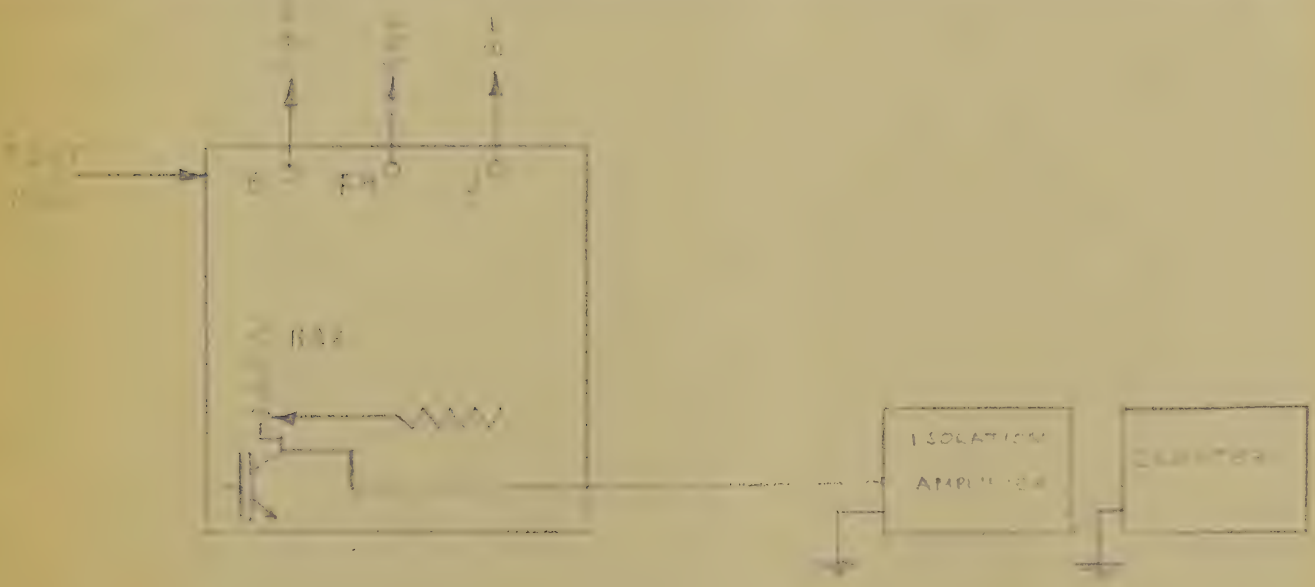


FIGURE NO 1



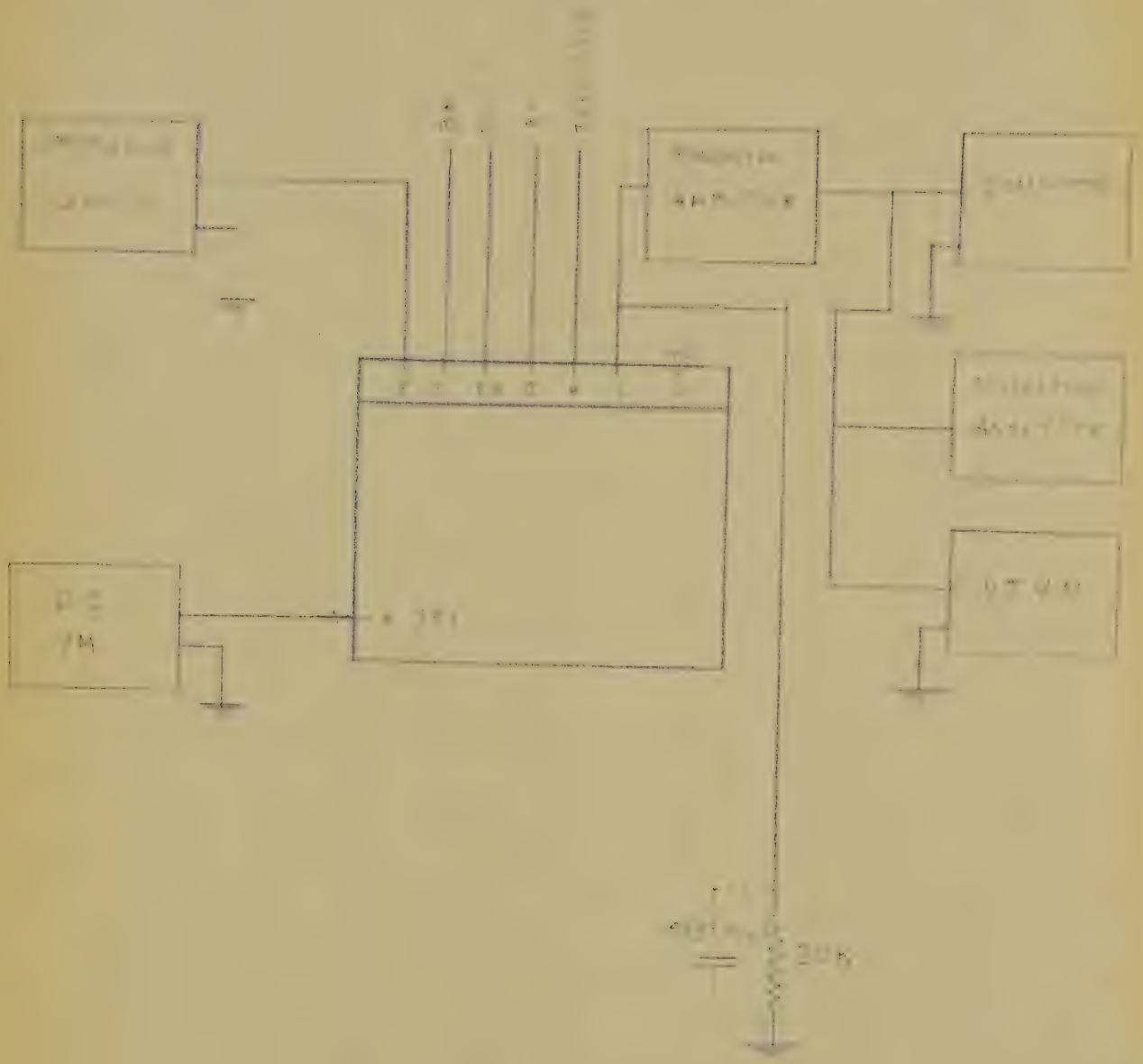


FIGURE 2

POST POT TEST:

CH # _____ S/N _____ B.W. _____

				65°C	Amb.-65°C	Output Voltage		% Distortion
Input Stimulus	Frequency	Increment of Deviation	f from Average	Frequency	f	AMB W.O. Cable W. Cable	65°C	AMB
Response Evaluation	BW	Avg. Linearity ±		B.W.	B.W.	Time	Inspector	Date
	%	±		%				
Input Stimulus	Tell Tale Open	Tell Tale Short	% Change		Name: _____			

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MANUFACTURING TEST PROCEDURE
VOLTAGE CONTROLLED OSCILLATOR
VCO-3A SET UP RECORD

Channel No. _____ S/M _____ B.W. = _____

I. FILTER CHECK:

Peak	Band Edges Upper	Band Edges Lower	Upper Adj. Band Edge	Lower Adj. Band Edge	Second Harmonic	Third Harmonic
Frequency						
Response 0.77V/0 db.	Variation db					

Name: _____ Date: _____ Time Spent: _____ Supervisor: _____

II. BLOCKING OSCILLATOR FREQUENCY

C10 _____ R21= _____

C11 _____ Frequency _____

Name: _____ Date: _____ Time Spent: _____ Supervisor: _____

III. CENTER FREQUENCY AND SENSITIVITY ADJUSTMENTS AND RECULATION CHECK

R10 (for complete discharge) = _____

Component					Frequency			
B+	B-	I+ ma	I- ma	Freq. -0.75v	Δ f	Freq. 0 v	Δ f	Freq. +0.75v	Δ f
28.0	28.0								
28.2	28.0								
27.5	28.0								
28.0	27.5								
28.0	28.5								

Name: _____ Date: _____ Time Spent: _____ Supervisor: _____

IV. TEMPERATURE COMPENSATION:

R8	R9	C4	C20	Ein	25°C	Frequency 25-65°C	Frequency 25°C
50K Initial Dalohm WWA-13							
Final							

Name: _____ Date: _____ Time Spent: _____ Supervisor: _____

V. FINAL SET CHECK:

	High	Center	Low
Frequency			
Stimulus			
Output Voltage			
Output Distortion			
Eo Ground Tell Tale			
Dist.-Ground Tell Tale			

Name: _____ Date: _____ Time Spent: _____ Supervisor; _____

REMARKS:

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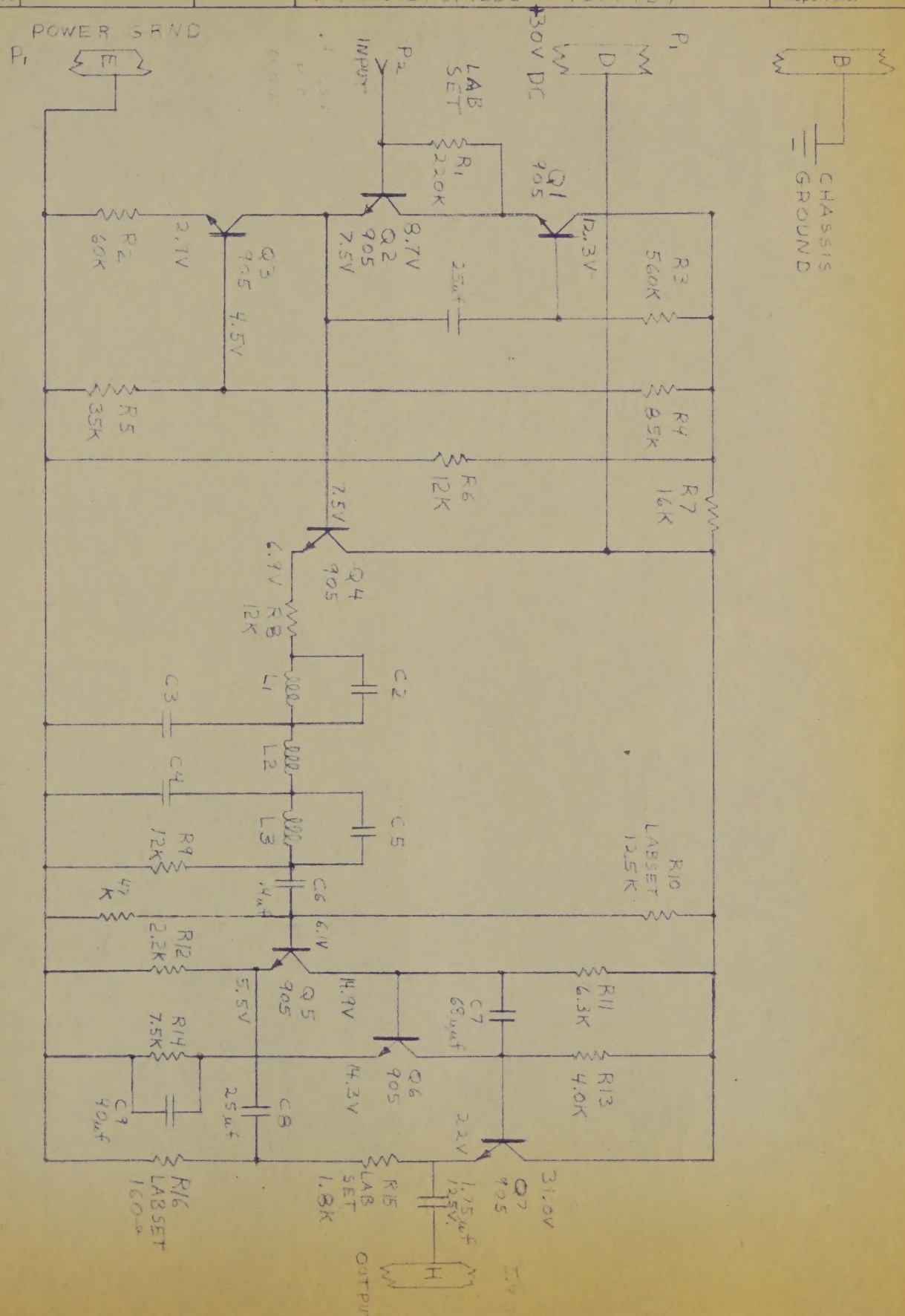
TABLE VI

Drift -% of Bandwidth	TEMPERATURE COMPENSATING RESISTOR - OHMS	ZERO TEMPERATURE COEFFICIENT RESISTOR - OHMS
+10	3000 + 0.4% C wirewound	47000
+9	2700 " "	47000
+8	2400 " "	47500
+7	2100 " "	48000
+6	1800 " "	48000
+5	1500 " "	48500
+4	1200 " "	49000
+3	900 " "	49500
+2	600 " "	49500
+1	300 " "	49500
0		50000
-1	5000 Deposited Carbon	45000
-2	10000 " "	40000
-3	15000 " "	35000
-4	20000 " "	30000
-5	25000 " "	25000
-6	30000 " "	20000

	NAME	DATE	LOCKHEED AIRCRAFT CORPORATION		TEMP	PERM
Prepared	W. Obenauf	5-27-57	MISSILE SYSTEMS DIVISION	Page		
Checked			TITLE: VIBRATION COUPLER	Model		
Approved			TRANSISTORIZED 1017959	Report No.		



FORM MSD 362B